

Chapter 12 Composting

12-1. General

Composting, equipment requirements, applications, and resulting waste streams are discussed in the chapter's first section. The second part of the chapter is a hazard analysis with controls and control points listed.

12-2. Technology Description

a. Composting Methods.

Composting is a biological remediation technology in which contaminants in soils, sediments, sludges, or soil-like materials are biodegraded or transformed to produce innocuous or stabilized byproducts.

During a composting operation, soils, sediments, sludges, or soil-like materials are treated ex-situ in piles or windrows (Figure 12-1). Populations of indigenous microorganisms are stimulated to grow and transform the contaminants. The following parameters are usually monitored or controlled:

- Mixing (tilling).
- Moisture content (controlled by irrigation or spraying).
- Oxygen level (controlled by tilling or aeration).
- Nutrients (nitrogen and phosphorus are provided by adding organic amendments).
- pH (soil and amendments usually provide sufficient buffering capacity).
- Soil bulking (controlled by blending organic amendments with soil).
- Temperature (proper mixing, moisture, and amendment selection is required to maintain thermophilic conditions).

In composting soils, sediments, sludges, or soil-like materials are mixed with organic amendments such as wood chips, manure, hay, and vegetable (e.g., potato) wastes. The process generates elevated temperatures (in the range of 43 to 65°C) from heat produced by microbial activity. Maximum degradation is achieved by maintaining thermophilic conditions for an extended period of time. Three different approaches to composting can be utilized:

- Compost is formed into piles and aerated with blowers or vacuum pumps (aerated static pile composting).
- Compost is placed in a reactor vessel where it is mixed and aerated (mechanically agitated in-vessel composting).
- Compost is placed in long piles (windrows) and periodically mixed with mobile equipment (windrow composting). Windrow composting is generally thought to be the most cost-effective form.

After the composting process is completed, the treated material is typically placed in designated locations on the site, in accordance with regulatory requirements.

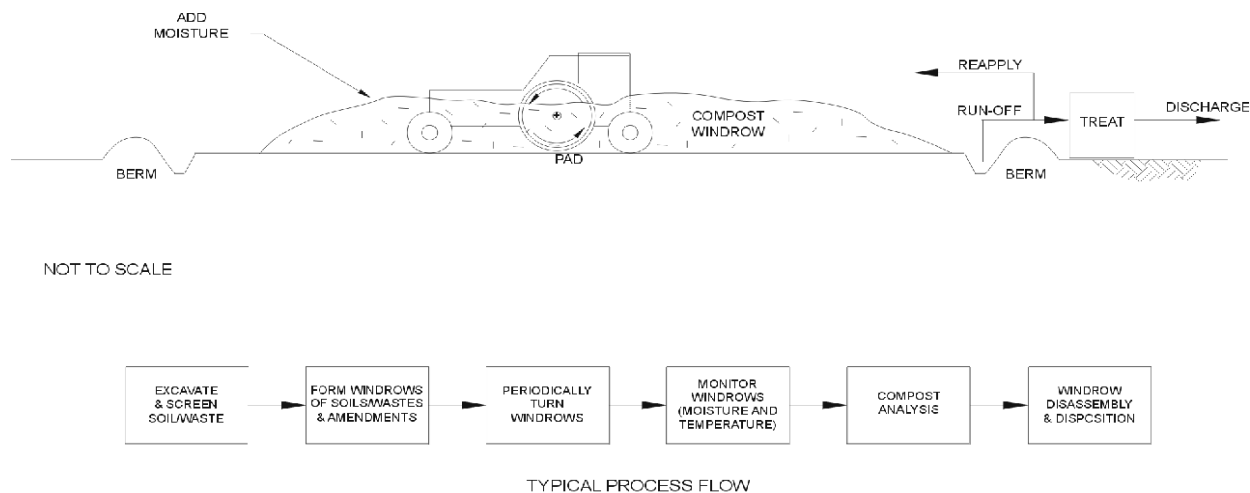


FIGURE 12-1. COMPOSTING

b. Equipment Requirements.

Composting techniques may utilize commercially available farm equipment such as tractors, rotary tillers, and irrigation devices. Composting requires substantial space and will result in a volumetric increase in material owing to the addition of the amendments. For hazardous waste applications, specialized implements are usually required to turn the compost.

c. Applications.

Aerobic, thermophilic composting has been shown to be effective for the remediation of explosives (TNT, RDX, and HMX), PAHs, and some pesticides. Although some solution may occur, composting does not treat heavy metals and most other inorganic contaminants.

d. Resulting Waste Streams.

Composting processes may produce three streams that may require additional handling:

- Wastewater (may require additional treatment).
- Treated soil (or soil-like materials).
- Volatile emissions.

12-3. Hazard Analysis

Principal unique hazards associated with composting, methods for control, and control points are described below.

a. *Physical Hazards.*

(1) *Equipment Operation.*

Description. During soil excavation and compost pile construction, workers may be seriously injured or killed by heavy equipment such as front-end loaders and scrapers. Construction may include the preparation of berms that may be steep and become slippery in wet or rainy conditions.

Control. Controls for equipment hazards include:

- Use heavy equipment with a backup alarms.
- Provide workers in the vicinity of operating heavy equipment with fluorescent orange or lime green traffic safety vests.
- Approach operating equipment from the front and within view of the operator, preferably making eye contact.
- Do not walk on or near the berms, especially during or after periods of heavy rainfall.
- Train workers on safe operation and safety features of the heavy equipment.

CONTROL POINT: Construction, Operations, Maintenance

(2) *Moving Equipment.*

Description. Windrows require periodic aeration using specialized equipment for turning the compost. Other devices, such as a scarab-type device may throw debris during the turning process. Pre-screening or sizing equipment, such as grinders, shakers, and screeners, may pose hazards if unguarded. Appendages or loose clothing may become entangled in pulleys, drive shafts, and other moving equipment.

Control. Controls for moving equipment include:

- Keep clear of operating equipment and approach only when within view of the operator.
- Guard all moving or rotating equipment to prevent accidental contact.
- Operate the system with the machine guards in place.
- Prohibit the use of loose clothing around the equipment.
- Train workers in pinch-point and entanglement hazard identification for the equipment in use.

CONTROL POINT: Construction, Operations, Maintenance

(3) *Sunlight/UV Radiation.*

Description. During site activities, workers may be exposed to direct and indirect sunlight with its corresponding UV radiation. Even short-term exposure to sunlight can cause burns and dermal damage. Hot and humid conditions, combined with heat from the composting process, can significantly contribute to the

worker's heat load, thereby increasing the risk of heat injury such as heat exhaustion, heat cramps, and heat stroke.

Control. Controls for sunlight, UV radiation and heat stress include:

- Minimize direct sun exposure by wearing sun hats, long-sleeved shirts, full-length unbloused pants, and by applying UV barrier sunscreen to exposed skin. Loose clothing and sun hats should not be worn around moving parts or close to operating equipment that may snag the worker and draw him or her into a danger zone. All UV skin barrier creams should be pre-approved.
- Shade work and break areas, if possible.
- Minimize exposure to heat stress conditions by training the workers in the symptoms of heat stress, practicing the Buddy System, taking frequent breaks, drinking adequate fluids, and working during the cooler part of the days. Tasks with inherent heat stress risks should be identified and PPE mandated. Heat stress levels and preventive measures as per accepted protocols shall be documented.
- Monitor for heat stress using the physiological or Wet Bulb Globe Temperature (WBGT) Index protocol provided in the most recent publication of the American Conference of Governmental Industrial Hygienists (ACGIH) "TLVs and BEIs: Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices."

CONTROL POINT: Construction, Operations

(4) *Puncture Hazards.*

Description. Workers may be exposed to puncture and cut hazards to feet and hands from rough or jagged waste materials during composting operations.

Control. Controls for puncture hazards include:

- Wear safety boots with steel shanks and puncture resistant soles to prevent punctures or cuts.
- Minimize manual handling of waste material.
- Wear puncture and cut-resistant gloves wherever contact with waste materials is required.
- Train workers to identify puncture and cut hazards unique to composting operations.

CONTROL POINT: Construction, Operations, Maintenance

(5) *Trip Hazards.*

Description. Trip hazards may exist with hoses and piping systems used for irrigation of the composting unit.

Control. Controls for trip hazards include:

- Exercise caution when walking over hoses and pipes.
- Use extra lighting if necessary to ensure adequately illuminated walkways.

- Train workers in potential trip hazards associated with working with composting equipment.

CONTROL POINT: Design, Maintenance

(6) *Fire.*

Description. Fire hazards may exist with composting, as elevated temperatures and drying may increase the potential for spontaneous combustion.

Control. Controls for fire hazards include:

- Mix composting material periodically and maintain the proper water content to control compost temperature and prevent fires.
- Reduce the dimensions of the compost windrows (and the piles of compost) to prevent temperatures from exceeding desired levels.
- Train workers in the potential hazards of exothermic biochemical processes occurring in composting.

CONTROL POINT: Design, Operations

(7) *Respirable Quartz.*

Description. Depending on soil types, exposure to respirable quartz may be a hazard. Consult geologists to confirm the presence of a respirable quartz hazard (e.g., to determine if soil types are likely to be rich in respirable quartz). As an aid in determining respirable quartz exposure potential, sample and analyze site soils for fines content by ASTM D422 (R2002): “Standard Test Method for Particle Size Analysis of Soils” followed by analysis of the fines by X-ray diffraction to determine crystalline quartz content.

Control. Controls for respirable quartz include:

- Wet the soil periodically with water or amended water to minimize worker exposure. Consult 29 CFR 1910.1000, Table Z-3, to calculate acceptable respirable dust concentrations based on percent silica in the quartz.
- Use respiratory protection, such as an air-purifying respirator equipped with a N, R or P100 particulate air filters.
- Train workers in the hazards of crystalline silica inhalation exposures.

CONTROL POINT: Construction, Operations

(8) *Electrocution.*

Description. Workers may be exposed to electrocution hazards when working around electrical utilities such as overhead power lines.

Control. Controls for electrocution include:

- Locate overhead power lines, either existing or proposed, in the pre-design phase.
- Keep all lifting equipment, such as cranes, forklifts, and drilling rigs, at least 10 feet from a power line according to Occupational Safety and Health Ad-

ministration (OSHA) regulation 29 CFR 1926.550 and EM 385-1-1, Section 11.

CONTROL POINT: Design, Construction, Operations

(9) *Equipment (Slopes).*

Description. Heavy equipment (small and large) used to move compost, soil, and liner materials on steep slopes may roll over, seriously injuring or killing the operator.

Control. Controls for equipment use on slopes include:

- Design the angle of the slope to minimize the potential for roll-over.
- Maintain safe operating conditions for equipment during construction.
- Use heavy equipment with roll-over protective devices (ROPS).
- Do not operate equipment on excessively steep slopes or unstable ground.
- Require the use of seat belts.
- Permit only properly trained and authorized personnel to operate or work in the vicinity of the heavy equipment.

CONTROL POINT: Design, Construction, Operations

(10) *Traffic Hazards.*

Description. During the implementation of field activities, equipment and workers may come close to traffic. Equipment may also need to cross or use public roads. The general public may be exposed to traffic hazards during loading and transporting soil.

Control. Controls for traffic hazards include:

- Post warning signs according to the criteria of the “Department of Transportation Manual on Uniform Traffic Devices for Streets and Highways.”
- Develop a traffic management plan before remediation activities begin to help prevent accidents involving site equipment. EM 385-1-1, Section 21, provides plan details.

CONTROL POINT: Design, Construction, Operations

(11) *Design Field Activities.*

Description. Design field activities associated with subsequent construction may include surveying, biological surveys, soil gas surveys, geophysical surveys, trenching, drilling, stockpiling, contaminated groundwater sampling, and other activities. Each of these field activities may expose the survey personnel to physical, chemical, radiological, and biological hazards.

Control. Controls for hazards resulting from design field activities include:

- Prepare an activity hazard analysis for predesign field survey activities. EM 385-1-1, Section 1, provides guidance on developing an activity hazard analysis.
- Train workers in hazards identified.

CONTROL POINT: Design

b. Chemical Hazards.

(1) *Contaminants.*

Description. Workers may be exposed to contaminants of concern and degradation products of contaminants. Exposure may occur via inhalation/ingestion/dermal contact routes during loading, unloading, preprocessing, tilling, turning, and other operations where soils are agitated.

Control. Controls for chemical contaminants include:

- Analyze work tasks and potential for chemical exposure to determine the correct personal protective equipment (PPE) or respirator cartridges, if needed. The analysis should include obtaining specific chemical hazard information to ensure appropriate PPE.
- Use respiratory protection, including an air-purifying respirator, e.g., equipped with N, P, or P100 or N, R, or P95 particulate filters or organic vapor cartridges, or both.

CONTROL POINT: Operations

(2) *Enclosed Facilities.*

Description. If composting facilities are enclosed or tented, workers may be entering a confined space and require respiratory protection. Elevated levels of CO₂ may accumulate during composting. It is also typical for some ammonia gas to be generated. Exposure to ammonia vapors may occur, especially during windrow turning operations. Although aerobic conditions should be maintained in the compost, if anaerobic conditions are allowed to develop, methane and hydrogen sulfide may be generated.

Control. Controls for enclosed facilities include:

- Test the enclosed atmosphere prior to each entry to ensure safety.
- Develop and implement a confined-space entry program if the testing indicates atmospheric contaminants or oxygen depletion (see 29 CFR 1910.146).

CONTROL POINT: Design, Operations

(3) *Explosion Hazards.*

Description. Some materials used in composting may be explosive, especially when in contact with other incompatible materials (e.g., ammonium nitrate and fuels). Others may be hygroscopic, which may result in chemical reactions.

Control. Controls for explosive hazards include:

- Train operators in the chemistry involved in the compost system design and operation, in the heat of reaction of the chemical reactions, and in handling the compost and compost chemical additives.
- Train operators in emergency procedures in case of a catastrophic event, in life saving first aid procedures including halting and neutralizing chemical reactions, extracting, decontaminating and stabilizing victims, and in emergency isolation and shutdown procedures.
- Minimize contact with acidic or corrosive chemical materials by using mechanical chemical delivery methods.
- Wear gloves (e.g., nitrile) and other PPE that is resistant to the materials handled.
- Segregate chemical reagents used in composting to prevent accidental mixing of reactive chemicals, especially ammonium nitrate fertilizers and fuels.

CONTROL POINT: Design, Operations

c. Radiological Hazards.

No unique hazards are identified.

d. Biological Hazards.

(1) *Pathogenic Microbes.*

Description. Composting activities may expose workers via inhalation/ingestion/dermal contact exposure routes to pathogenic microbes. The hazard may increase during dry and windy periods when microbe-entrained dusts may become airborne from soil agitation, aerators, or wind. Exposure may occur during agitation of the waste material. It is possible for pathogens to be present in compost amendments (e.g., bird manure has been implicated as a source of histoplasmosis). Exposure to mold spores, including *Aspergillus fumigates*, may occur during composting operations. Inhalation of pathogenic microbes may cause allergic reactions or illness.

Control. Controls for pathogenic microbes include:

- Apply water periodically to limit airborne dust and exposure.
- Use PPE, such as rubber gloves, to help prevent dermal exposure to microorganisms.
- Use respiratory protection, such as an air-purifying respirator with N, R or P100 or N, R, or P95 particulate filters, approved for microbial hazards during dusty periods.

CONTROL POINT: Construction, Operations

(2) *Snakes and Harmful Animals.*

Description. Snakes and other potentially harmful animals such as rodents are attracted to the higher temperatures associated with composting operations.

Control. Controls for snakes and other animals include:

- Inform workers of the potential for snakes and other animals around the compost facility, especially during cooler periods and provide training in the potential hazards associated with the presence of these animals.
- Use loud noises, such as talking and stamping or scuffing feet, to alert animals to the presence of workers in the area.

CONTROL POINT: Operations, Maintenance

(3) *Pests.*

Description. Workers may be exposed to a wide array of biological hazards, including snakes, bees, wasps, massive fly hatches, ticks, hornets, and rodents during any phase of remediation. The symptoms of exposure vary from mild irritation to anaphylactic shock and death. Deer ticks may cause Lyme disease. Rodents can transmit Hanta virus. Mosquitoes can transmit the West Nile Virus.

Control. Controls for pests include:

- Periodically inspect the site to identify stinging insect nests and to check for snakes and rodents.
- Use professional exterminating companies if necessary.
- Use tick and insect repellents such as formulated with N,N-diethyl-m-toluamide (DEET) 25% as the active ingredient for exposure control. Clothing may be treated with permethrin clothing repellent BEFORE donning, for added protection. Workers should check their skin and clothing for ticks periodically.

CONTROL POINT: Construction, Operations, Maintenance